

Teleimmersive and Intra Site Remote Sensing Archaeology: Collaborative Research in 3D

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Abstract

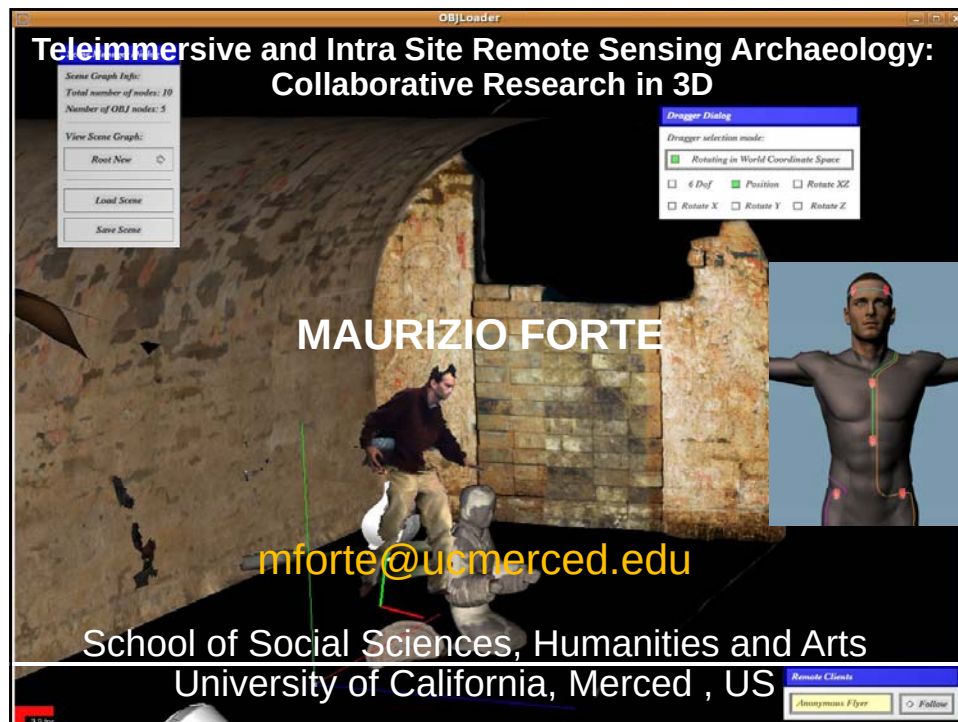
In modern archaeology large amounts of data are generated through the use of 3D laser scanners, photogrammetry, digital photography, remote sensing, computer vision and other forms of digital archiving process. For interpretation and isualization of data the archaeologists use a variety of specialized software tools (some open source), which can usually handle specific type of data at a time. These tools allow for stand-alone data decimation, analysis, visualization, archiving, and ontextualization. In the end there is a lack of integration of tools in order to allow for comparison of different data sources. Majority of the tools also do not provide a straightforward way of sharing data within a large community of users and scholars.

Virtual reality offers flexible modality for visualization, exploration and interaction with spatial data. Shared virtual environments can provide remote user access to these data. The aim of the proposed Telimmersive framework (TeleArch) is to integrate different data sources and provide real-time interaction tools for remote collaboration of geographically distributed scholars. The framework also includes optional audio and video streaming technologies, which create a virtual presence of the remote user inside shared virtual space.

The primary goal of 3D collaborative research is to develop real-time interaction to access and manipulate 3D spatial data remotely by multiple participants. In Teleimmersive archaeology the interpretation process is the result of embodied participatory activities whereas multiple users/actors construct a new digital

hermeneutics of archaeological research from the fieldwork to virtual reality communication. This cyberspace augments the possibilities to interpret measure, analyze, compare, illuminate and simulate digital archaeological models according to different research perspectives while sharing data in the same space.

First experiments of Teleimmersive archaeology are in progress between the University of California Merced, Berkeley and Davis with different case studies including the Neolithic site of Catalhoyuk (Turkey), the Chinese Western Han tombs and the Mayan city of Copan.



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Overview

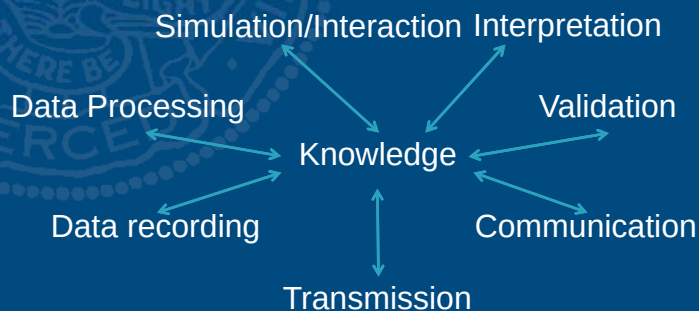
- Digital Hermeneutics in archaeology
- 3D Interpretation
- Simulation
- Data capturing – Case studies
- VR and collaborative systems
- Teleimmersion Archaeology

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Hermeneutics

- The art, skill, theory, and philosophy of interpretation and understanding
- *The question is not so much what we understand as how we understand* (Johnsen, Olsen, 1992)
- Knowledge and context
- The historical or hermeneutic sciences deal with communication, understanding, meaning and action (cf. Patrik 1985)
- Digital hermeneutics deals with embodiment, enaction, interaction, feedback, immersivity, situated environments and cybernetic transmission
- Interpretation is a translation process
- New Research Questions

Digital Archaeological Hermeneutics



Data

Digital memory

- Documentation
- Fieldwork
- Data entry
- Repositories
- Archives

Performance

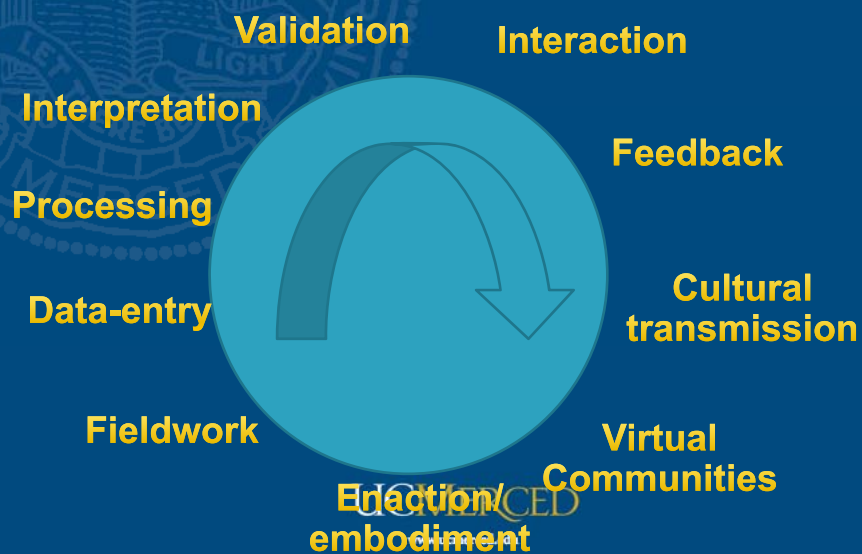
- 3D modeling
- Simulation
- Interaction
- Embodiment
- Enaction

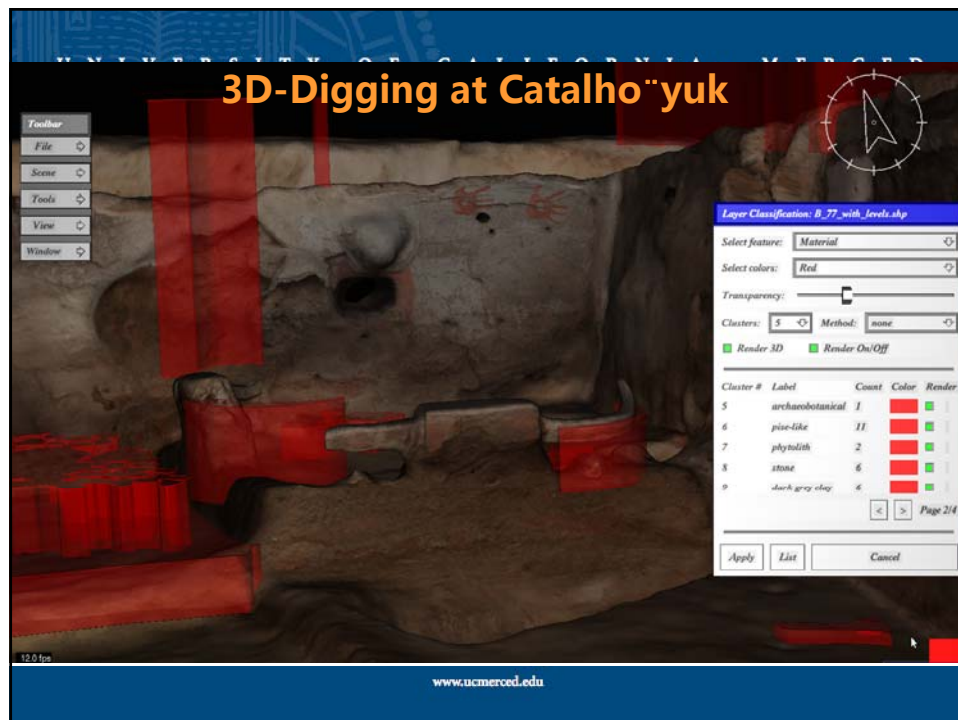
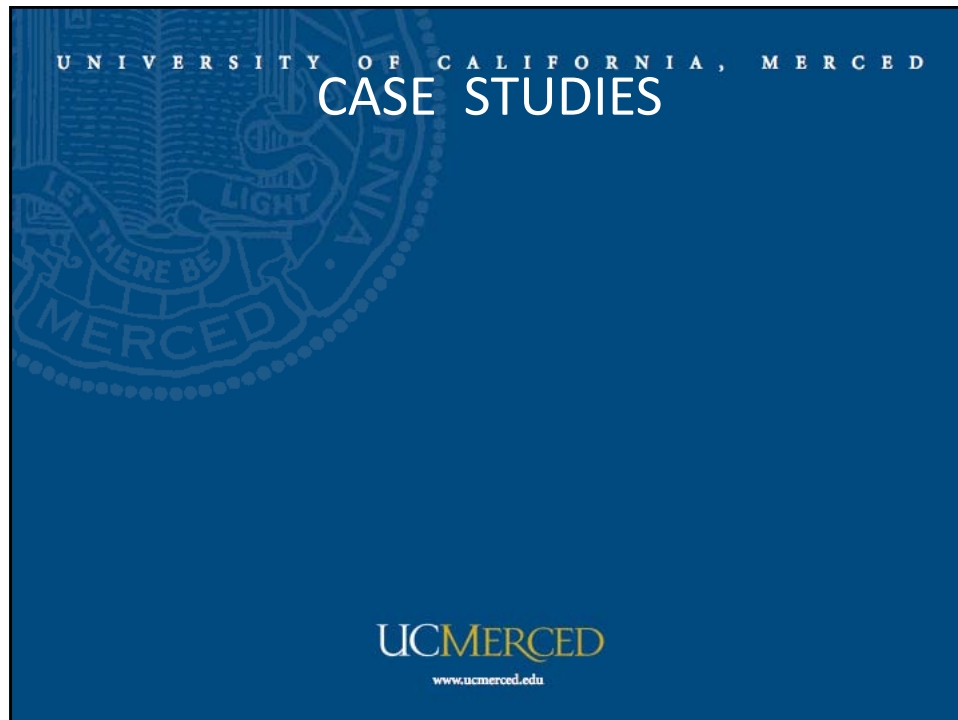
Interpretation

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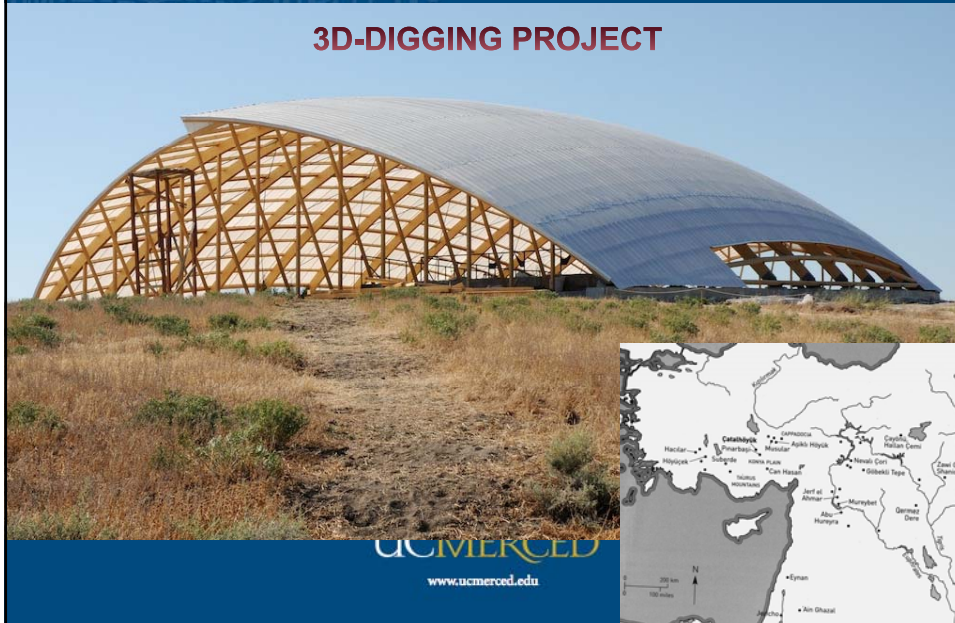
Cybernetic circle





Catalhuyuk (East Mound)

3D-DIGGING PROJECT



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Goals

- To interpret an archaeological excavation in 3D using advanced technologies for visualizing and interpreting structures, objects, artifacts and stratigraphic layers.
- In order to reach this goal all the fieldwork activities are based on 3D data recording by laser scanning, digital stereo cameras, digital photogrammetry, computer vision and remote sensing.

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Purposes

- Preservation of the site. The fragile archaeological structures and remains of the site have to be documented in detail and with very sophisticated instruments before time and environmental factors can damage them.
- Reconstruction of all the excavated structures. Part of the site is open to visitors but it is very difficult to interpret the site in a comprehensive broader vision. The 3D documentation will display this content in a very innovative way and in different locations.
- Data recording of small size artifacts (figurines, pottery, artifacts).
- Experimental use of different integrated technologies and models. From the technological point of view the project could test the effect of different instruments and tools on the same case study.
- Stereo visualization of 3D data during the excavation. The use of portable stereo systems of visualization (video-projectors, 3D displays) on the excavations will involve the archaeologists to analyze daily the data recorded in stereo-vision.
- Use of virtual collaborative environments for interpreting data and testing the reconstructions.

Technologies

- Time of flight scanners
- Optical scanners
- Computer vision

Catalhuyuk (East Mound, B87, 2010)

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Scanners



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Processing: F.Galeazzi

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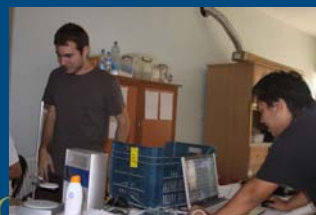


Trimble: time of flight scanner

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Optical Scanners in Lab

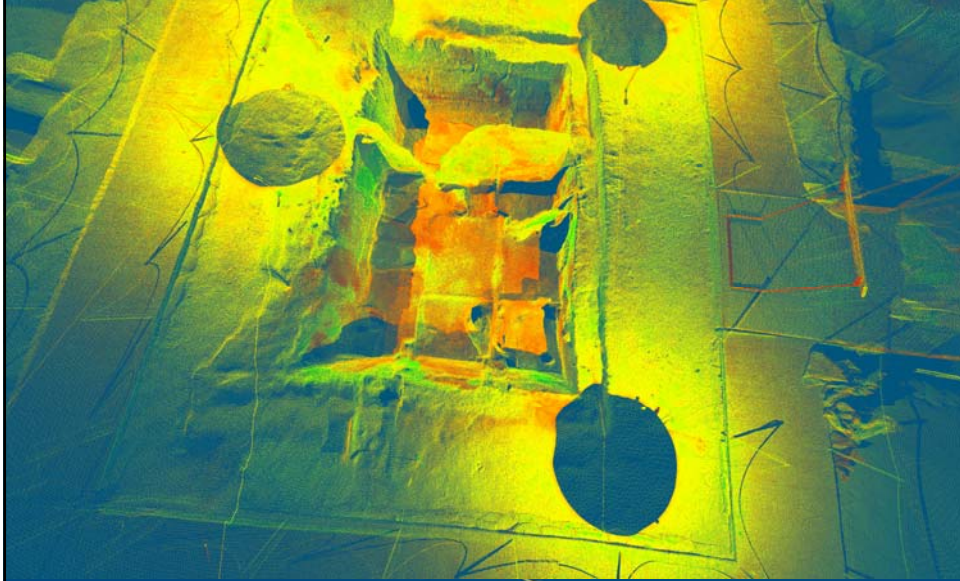


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Exhibit: 3D Archaeology at Catalhuyuk, Stanford, 2011



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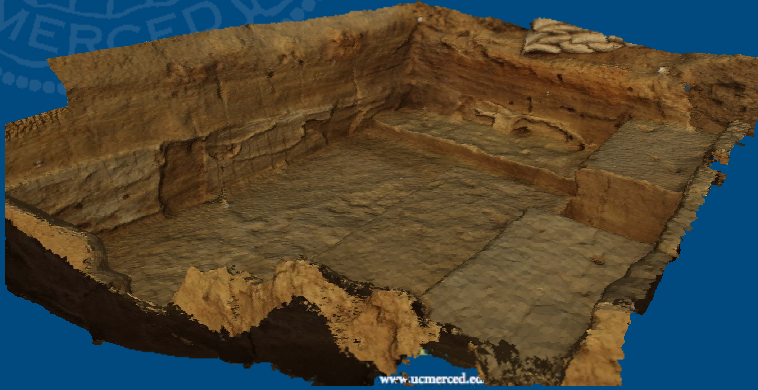
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B89, Image modeling (130 photos)

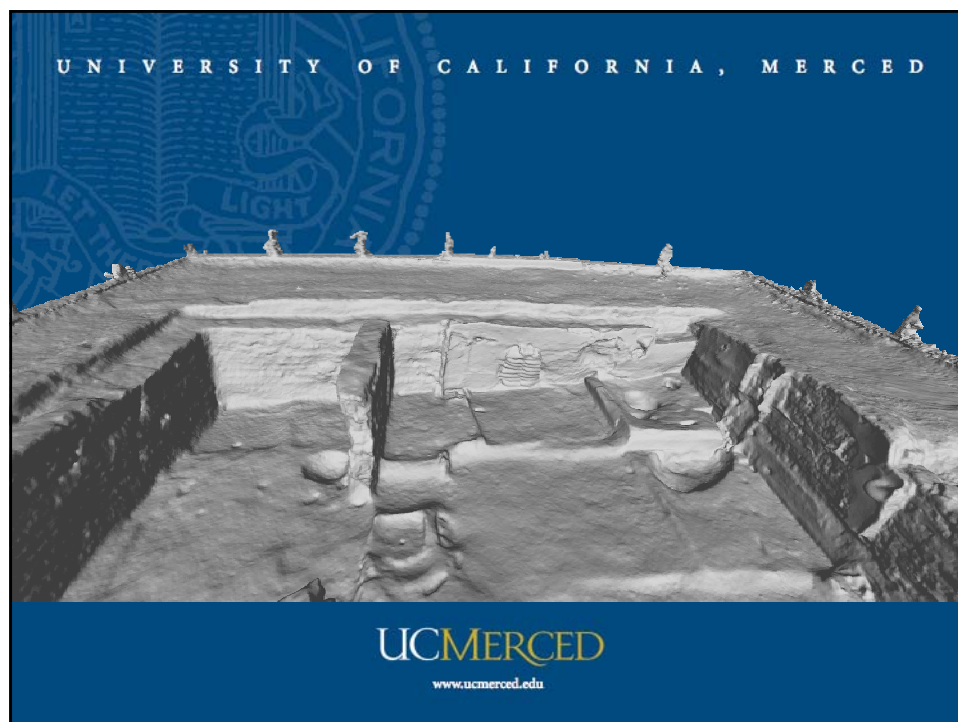


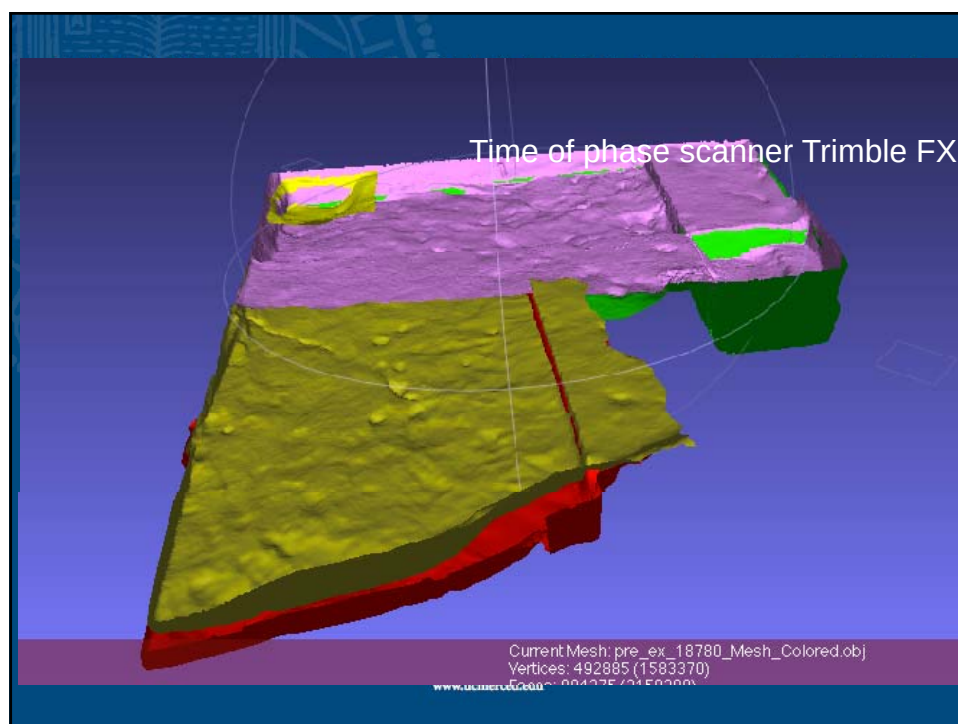
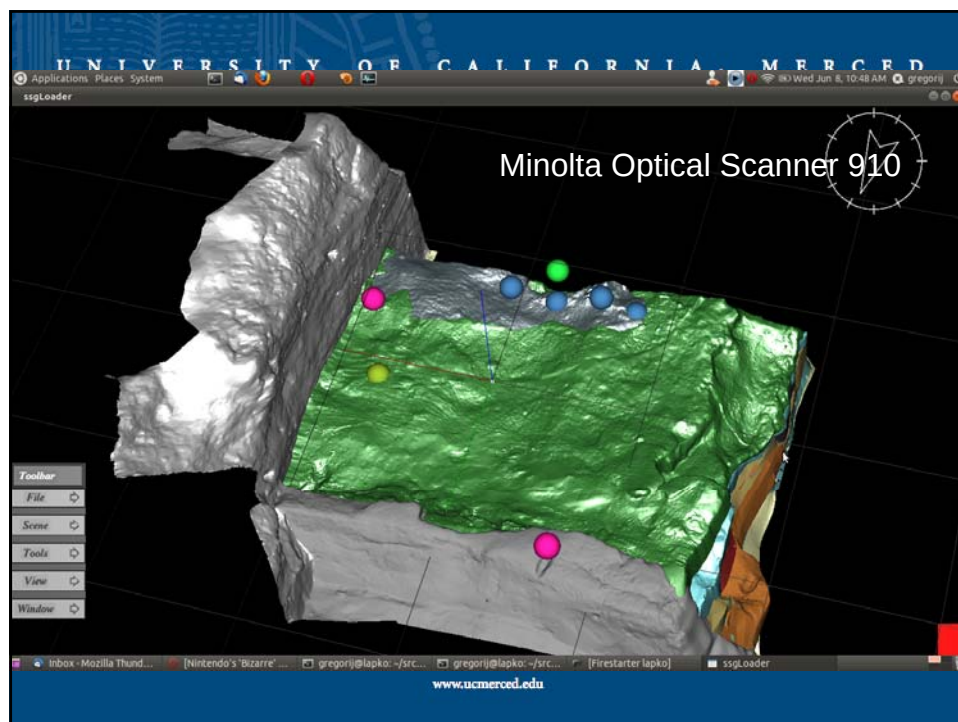
U B89, Image modeling (with stratigraphic units) E D

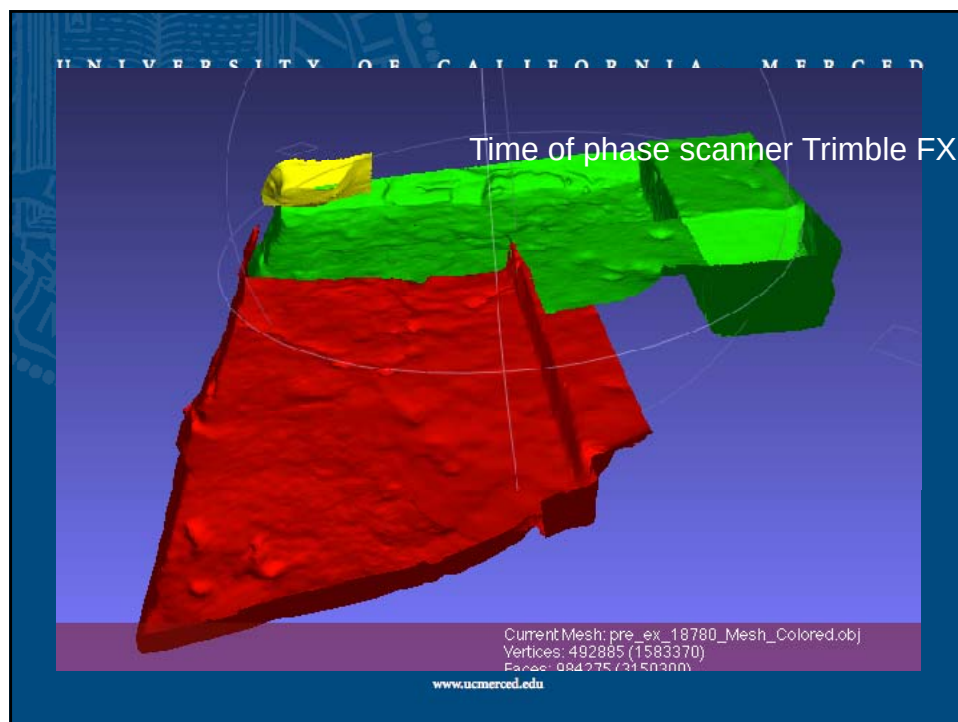


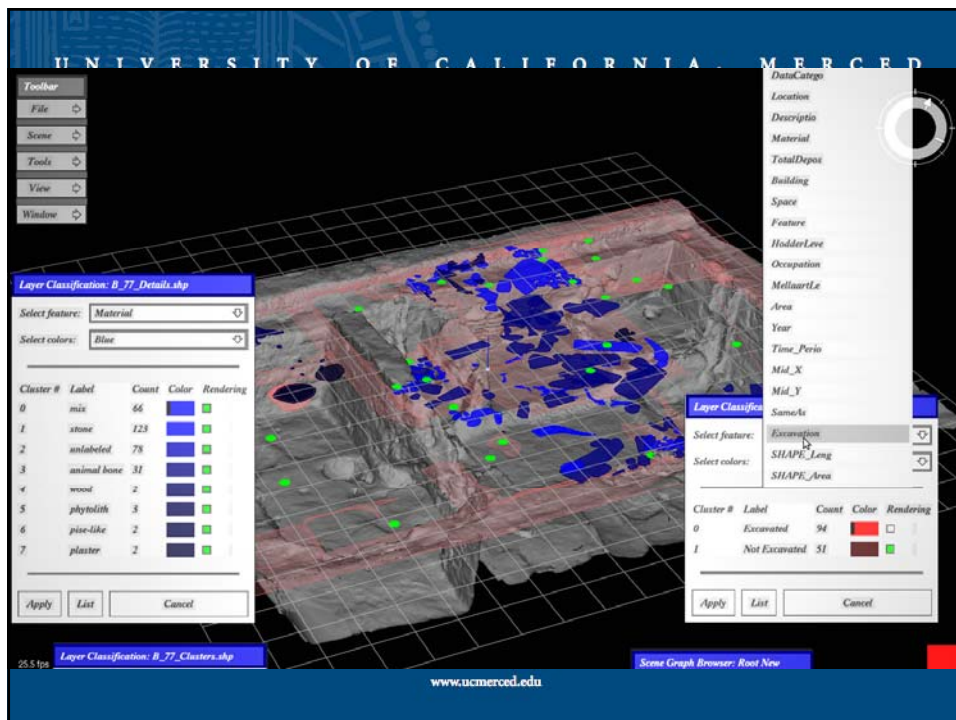
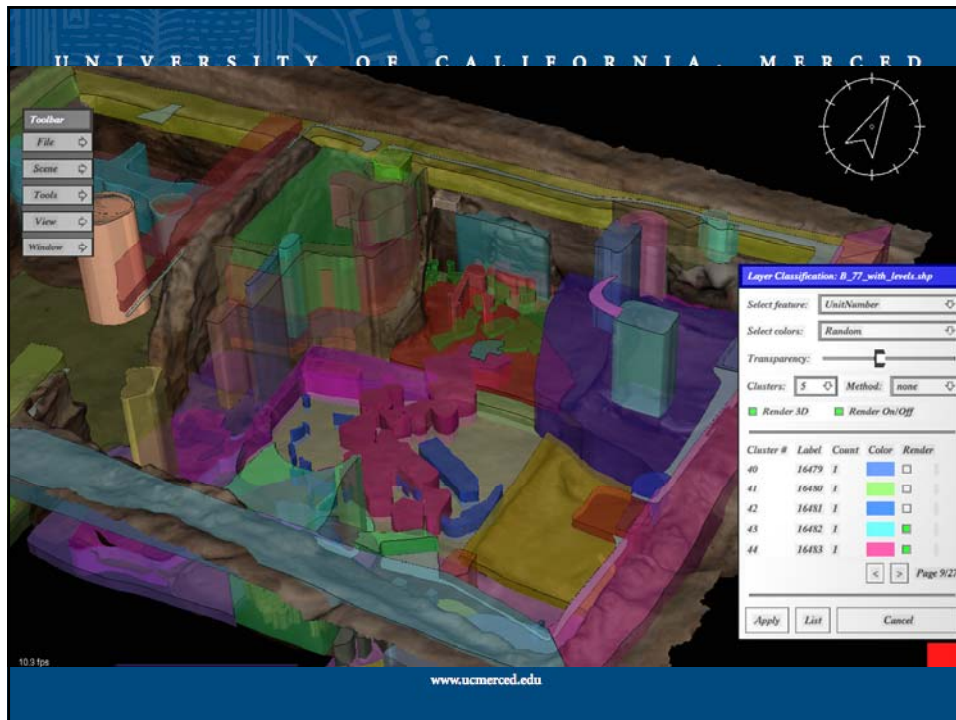
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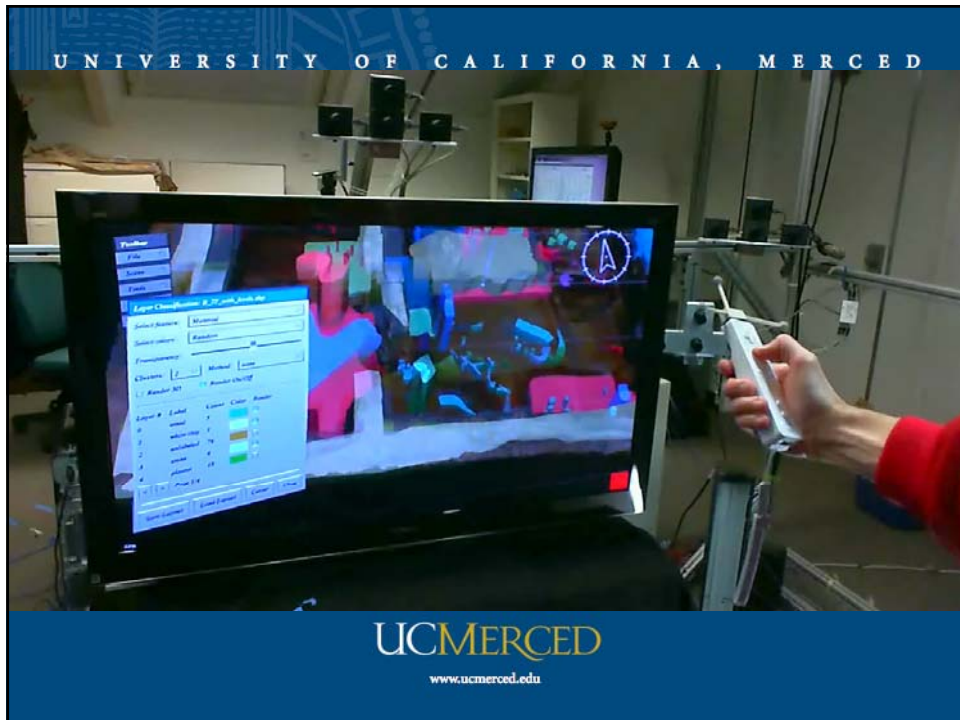




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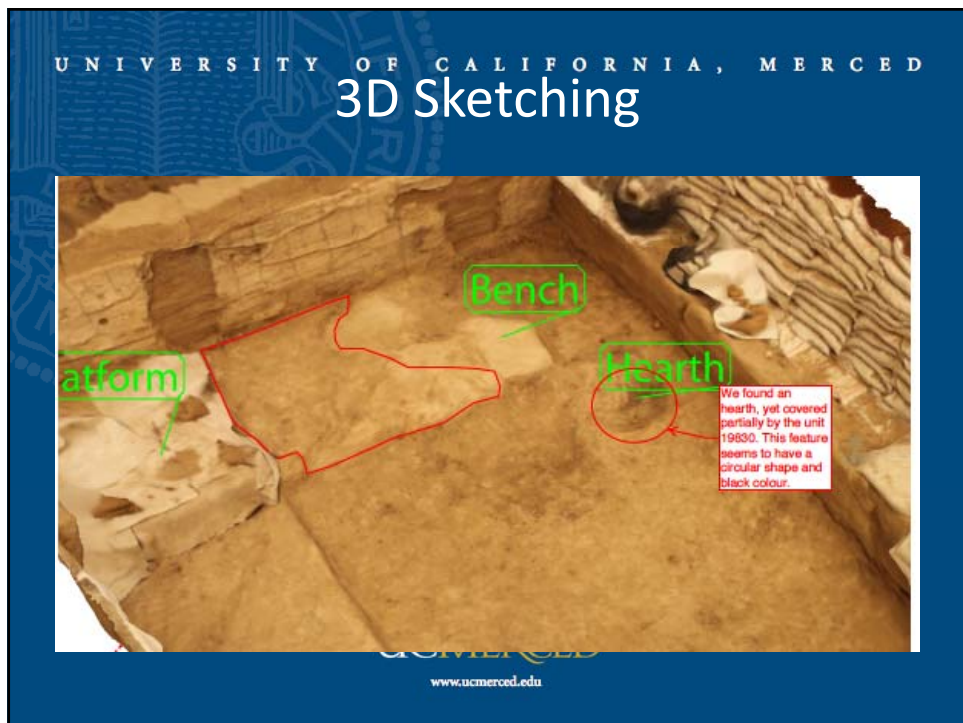
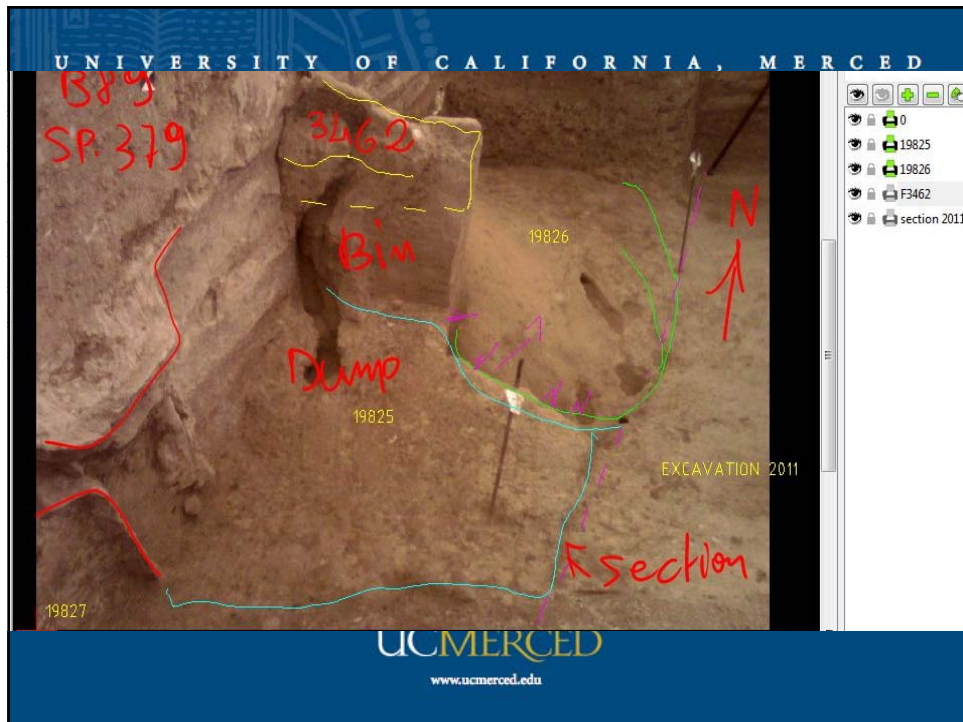


Technologies 2012

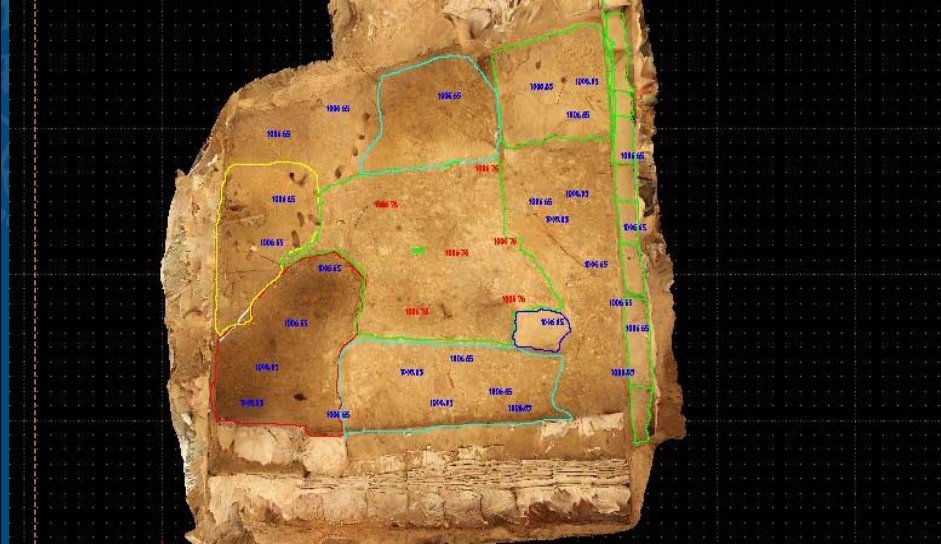
- Time of phase laser scanner Faro Focus 3D
- Optical Scanner Nextengine
- Tablet PC Motion Computing
- Wireless Simcard SimEye
- Gigapan Set
- 2 Digital cameras Canon, 400D, EOS 60D
- Stereo camera Fujitsu 3D
- Infrared camera Flyr
- 6 laptops

News 2012

- More computer vision and more teams involved
- Standardization of all the procedures
- Burials
- More fast and efficient 3D laser scanning
(122,000 / 244,000 / 488,000 / 976,000
points/sec)
- GIS compatibility (in-out)
- All the data daily aligned, georeferenced and
ready
- 3D Sketching in PDF format



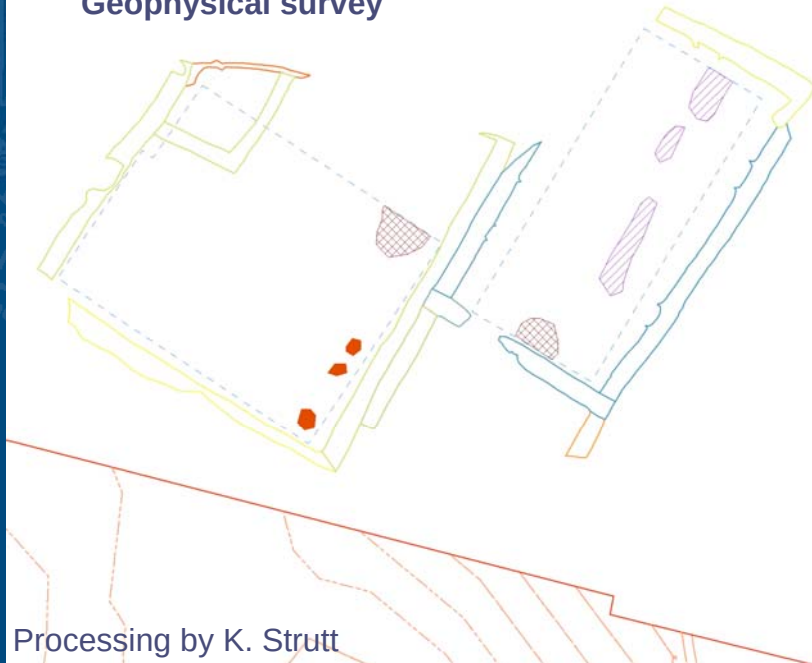
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2D DRAWINGS BY CAD ON ORTHOPHOTO



INFRARED CAMERA ON B80

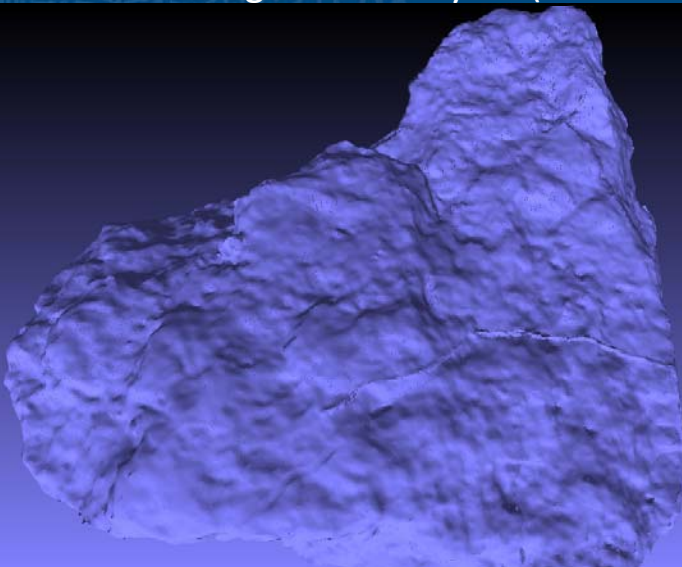


Geophysical survey



Processing by K. Strutt

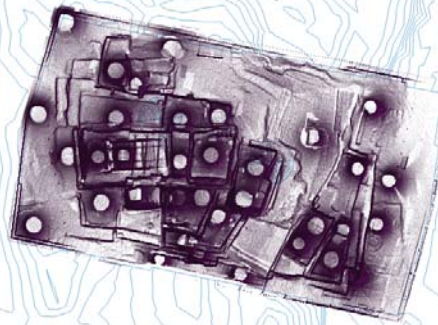
UNIVERSITY OF CALIFORNIA, MERCED 3D Scanning of microlayers (Unit 19835, B89)



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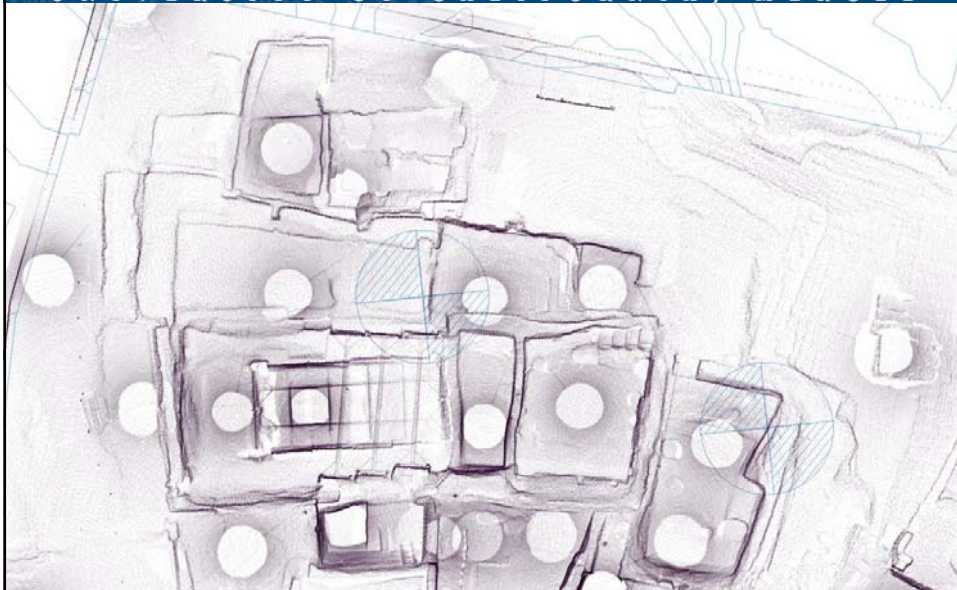
Model made by A.Asaro

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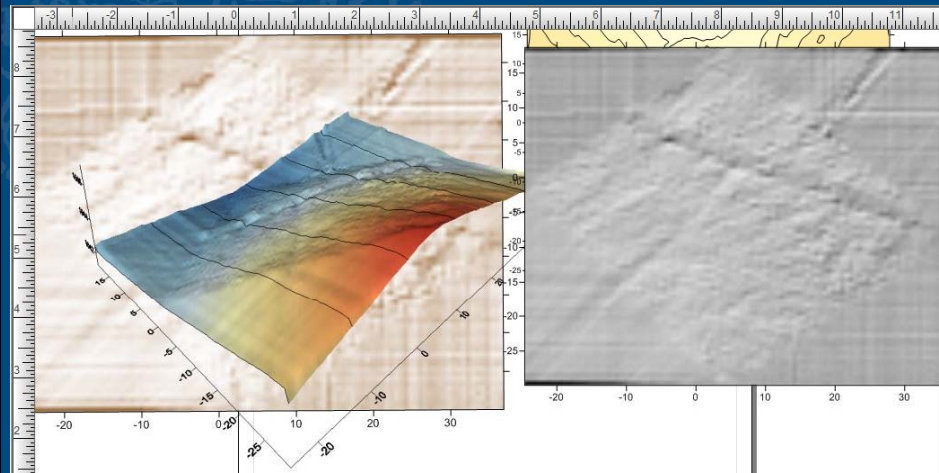
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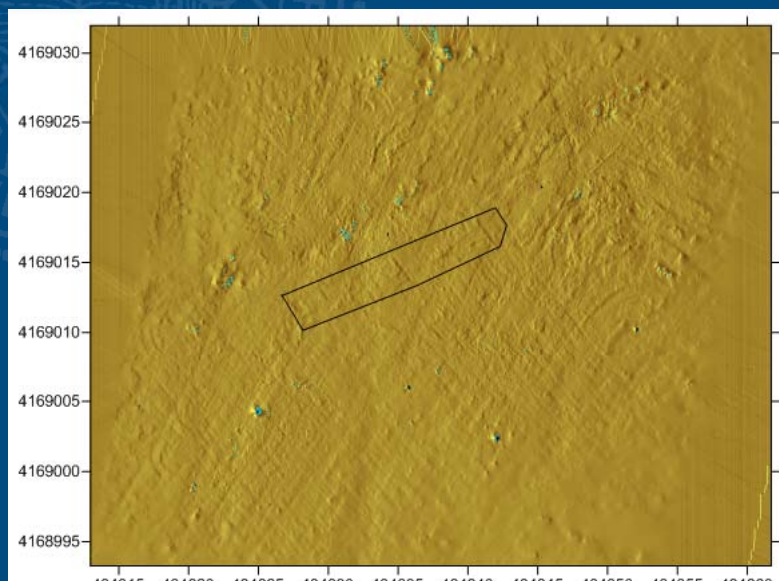
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DEM by Laser Scanning (300k points)



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DEM by Laser Scanning (300k points)



What after?

- Query, comparisons and analyses of data
- Distribution and communication of data
- Reconstruction
- Simulation
- What's more? Performing models, data in collaborative environments
- Virtual performance

Tele-immersion lab, Hearst Memorial Mining Building, UC Berkeley



Aims of this Work

- Build a shared virtual environment to allow for virtual fieldwork activities through 3D teleimmersion
- Register and integrate different 3D and other data sources in the same space
- Provide communication platform for real-time interaction of multiple users through audio and 3D/2D video

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Teleimmersion

- Tele-immersion connects remote users through a shared virtual environment
- Users are captured in real-time using stereo cameras to obtain their 3D avatar (captured as 3D mesh)
- Geometry of the real world is preserved and mapped into virtual environment



Tai Chi Teaching
(UCB, Stanford Univ.)



Remote Dancing
(UCB, UIUC)



Virtual
Choreography
(UCB, UIUC)



Portable
Teleimmersion
(UCB)

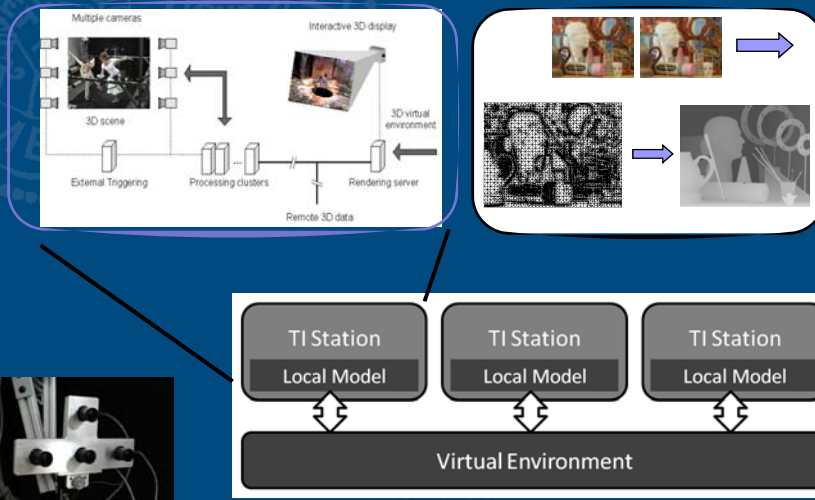


Cyber Archaeology
(UCM)

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UNIVERSITY OF CALIFORNIA, MERCED Teleimmersion System



UNIVERSITY OF CALIFORNIA, MERCED 3D Video Capture

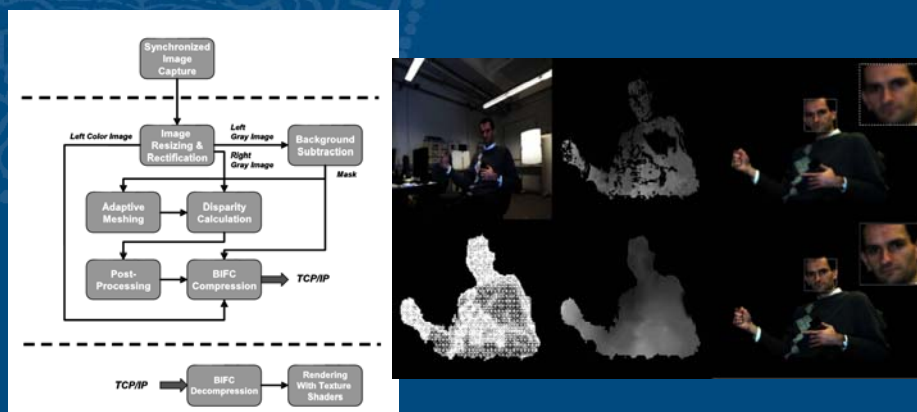
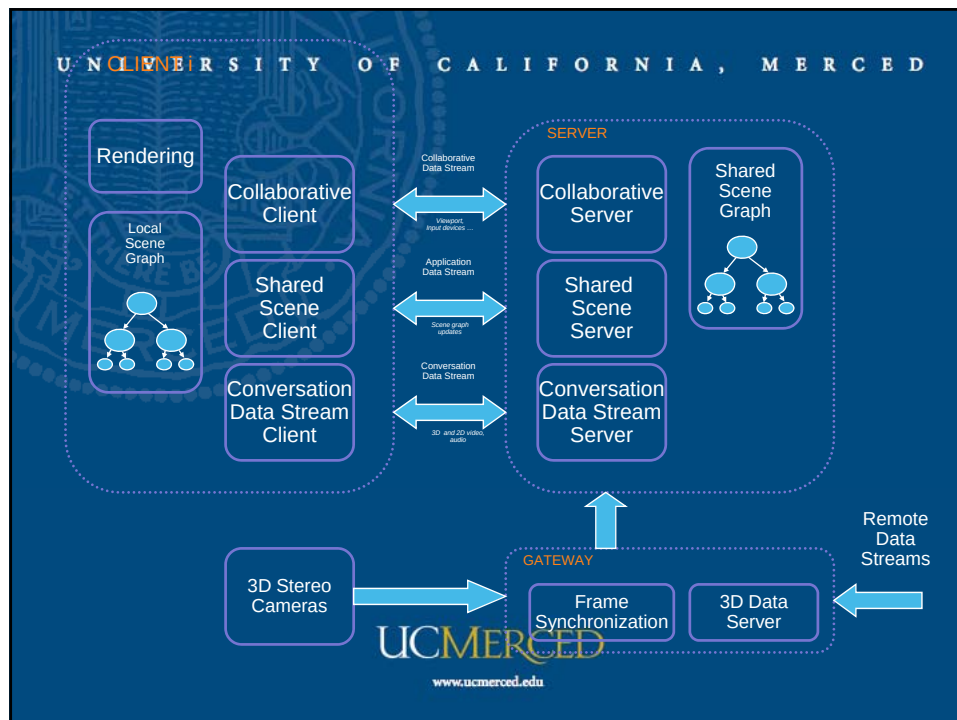


Diagram flow of the 3D reconstruction algorithm from point of image capture to transmission through TCP/IP.

Intermediate and final results of the real-time 3D reconstruction (image, meshing, calculated depth-map, depth-map after post-processing, rendering in virtual environment without and with texture mapping).

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Virtual Tools

- **Navigation Tools** → navigation through 3D space
- **Graphic User Interface Tools** → interaction with menus
- **Draggers** → moving and rotation objects
- **Screen Locators** → rendering manipulation (e.g. mesh vs. texture)
- **Annotation Tools** → marking and communicating interesting features to others
- **Pointing Tools** → laser pointer, flashlight etc. used to point at interesting features

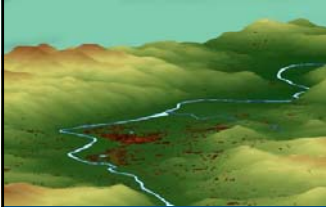
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Department of Art and Art History, College of Fine Arts
Department of Architecture, School of Architecture and Planning

Digital Documentation and Reconstruction of an Ancient Maya Temple and Prototype of Internet GIS Database of Maya Architecture

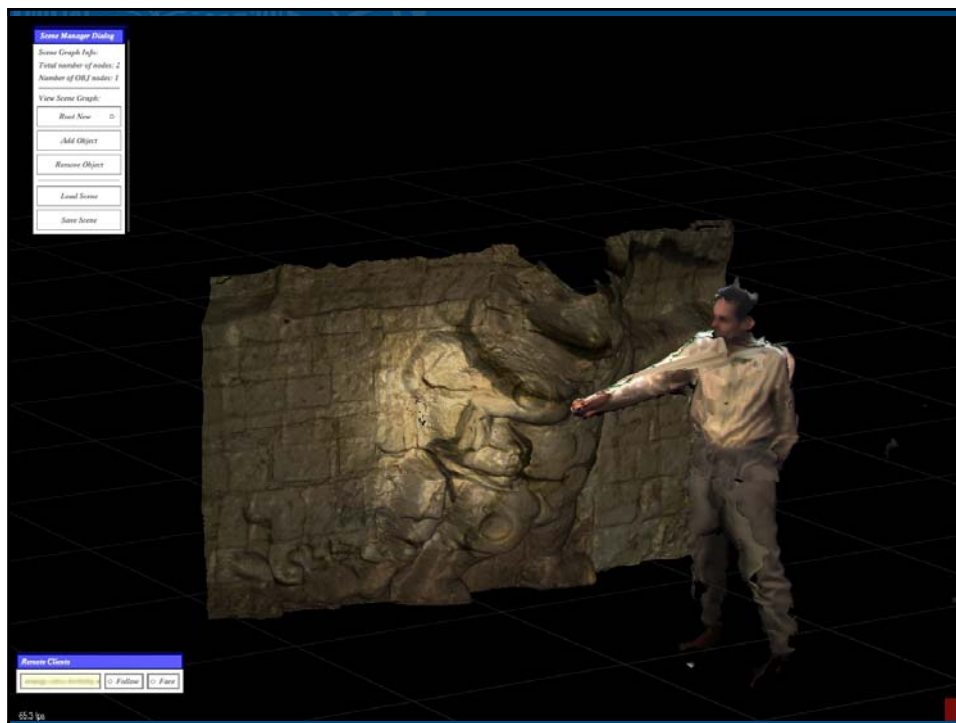


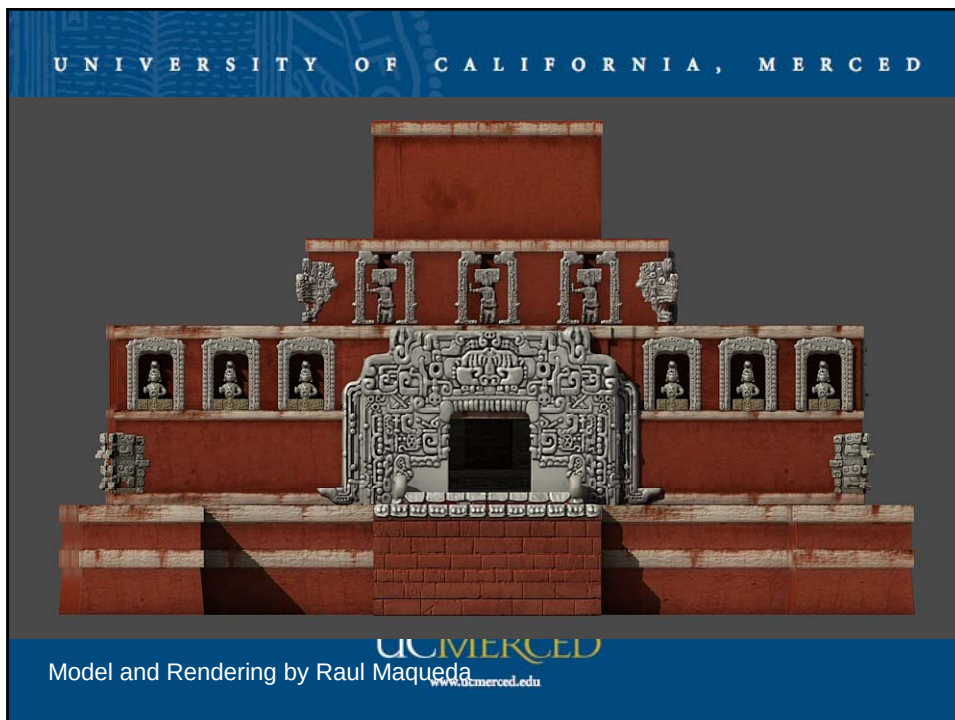
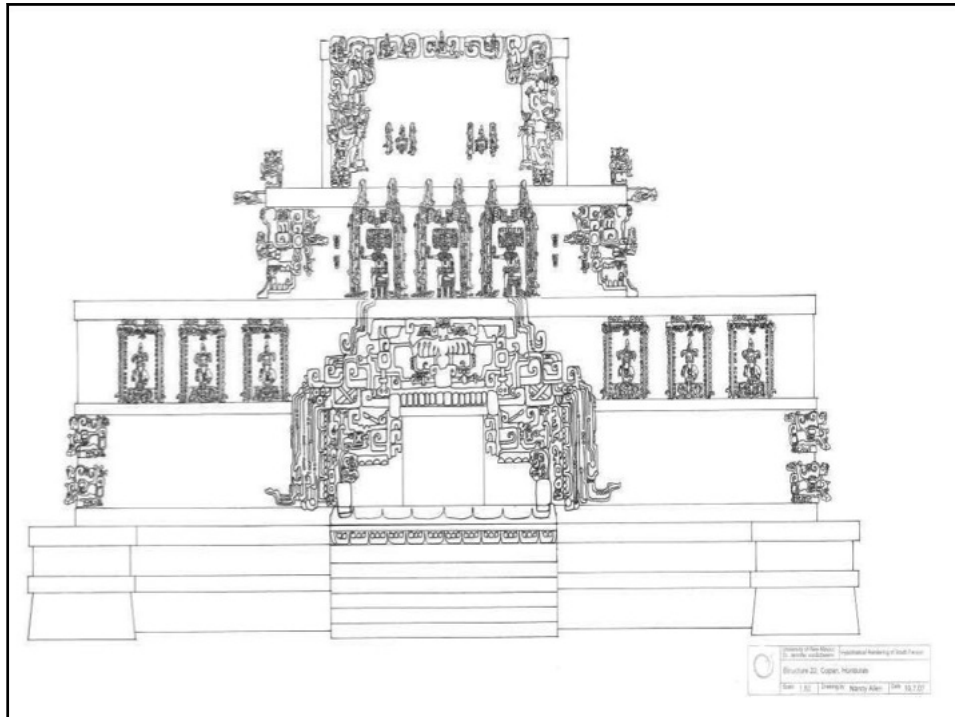
An international, collaborative project involving computer experts, archaeologists, architectural historians, and cultural heritage managers who are seeking how to reinvent how we integrate 3D objects, virtual reality environments, and GIS maps in a single, open-source web environment for use in research and teaching on ancient architecture.

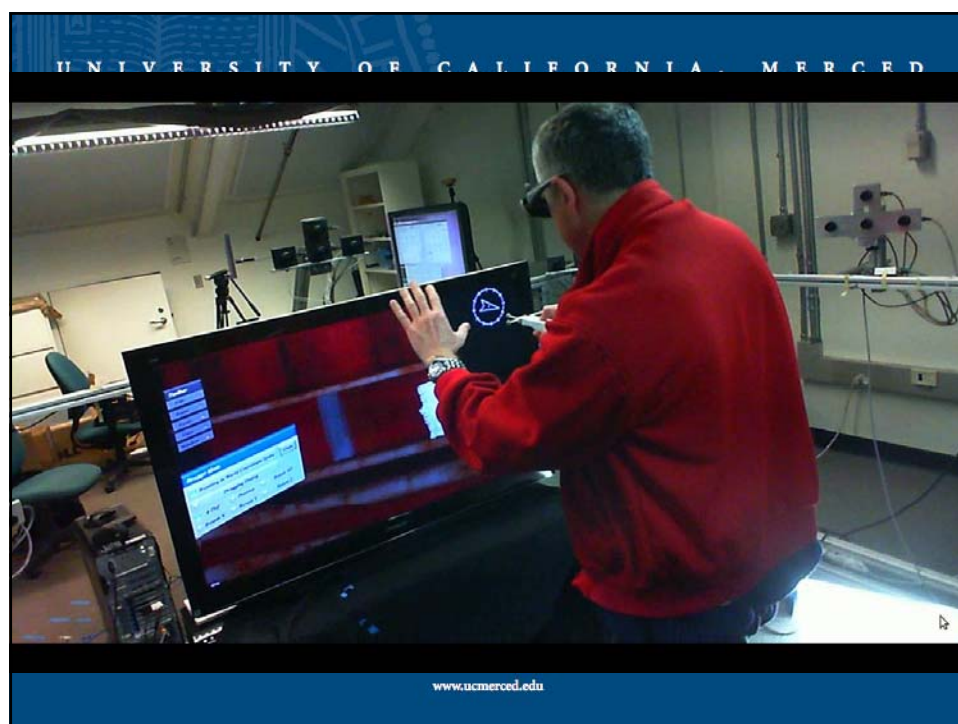
Start-Up Level 2 Grant - Prototype Development:
to develop a prototype of a GIS-based, web-interface database (3D Web GIS) of ancient architecture that can curate, search, and compare digital objects (such as drawings, maps, diagrams, text, photographs, and videos) but also highly accurate 3D scans of sculpture and 3D architectural models in a virtual environment.

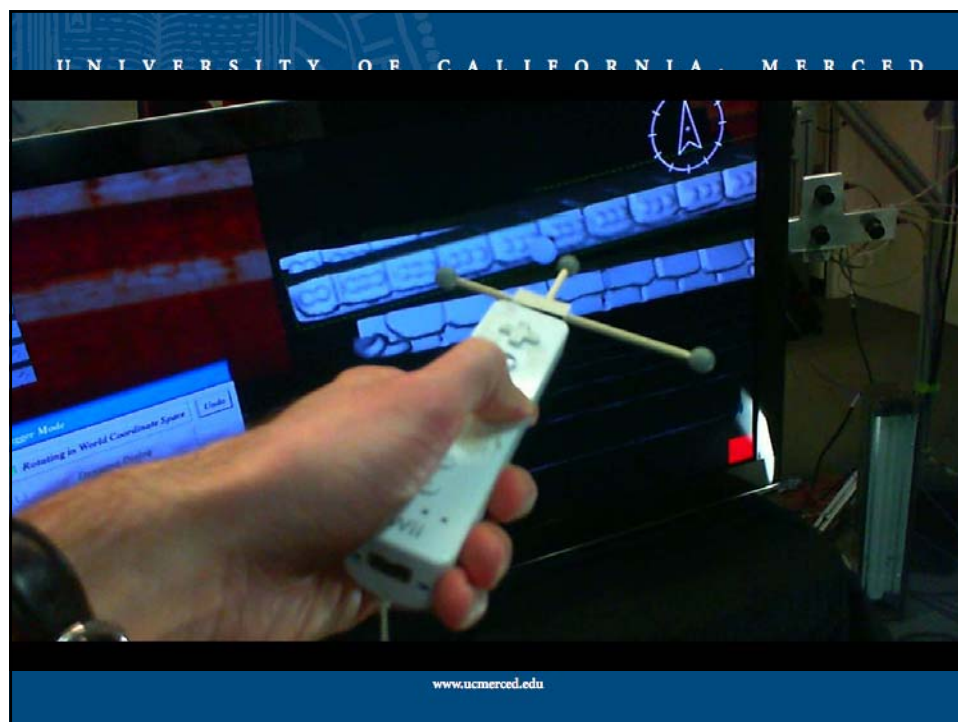
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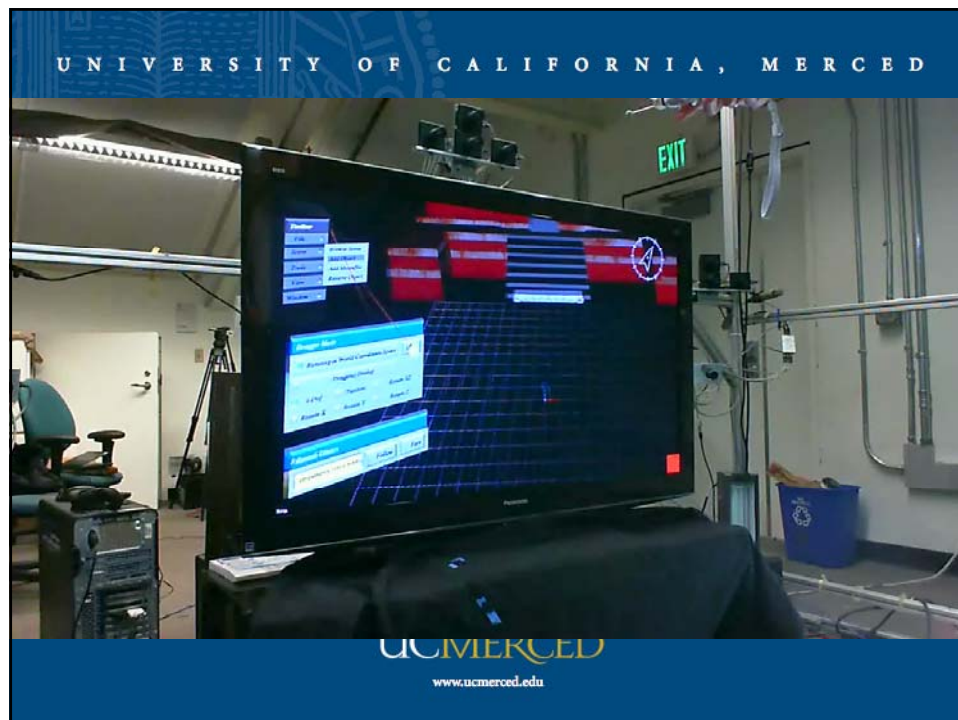


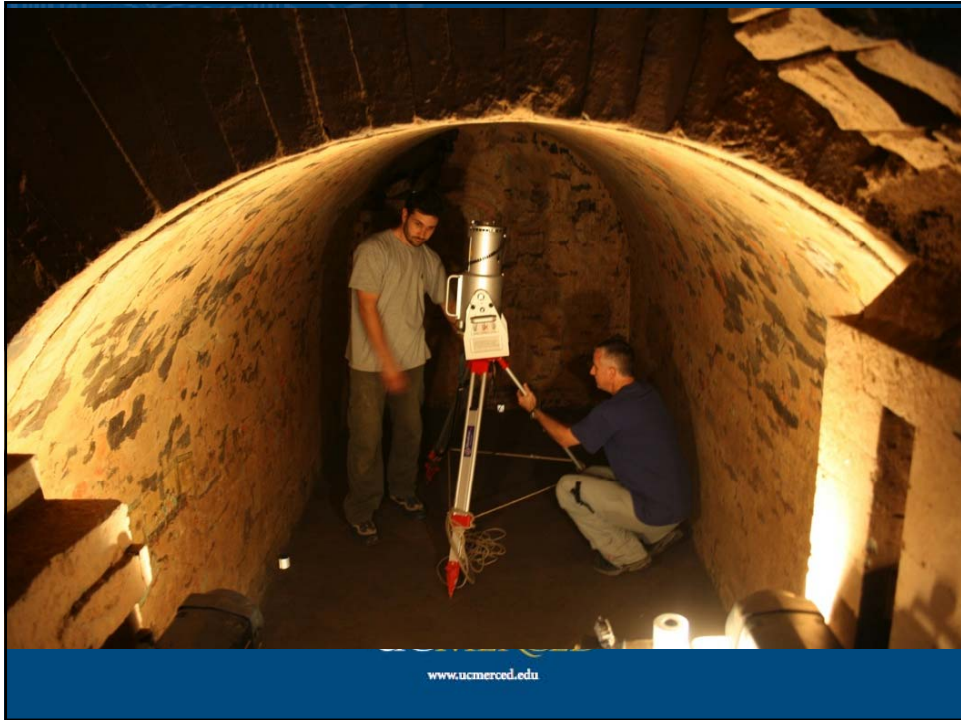


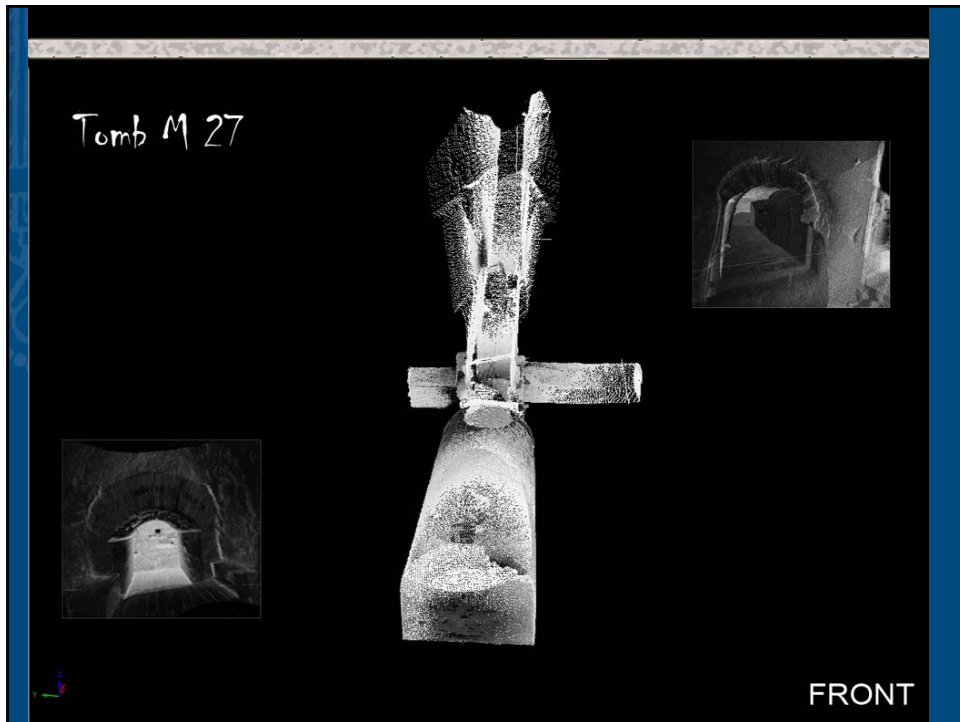


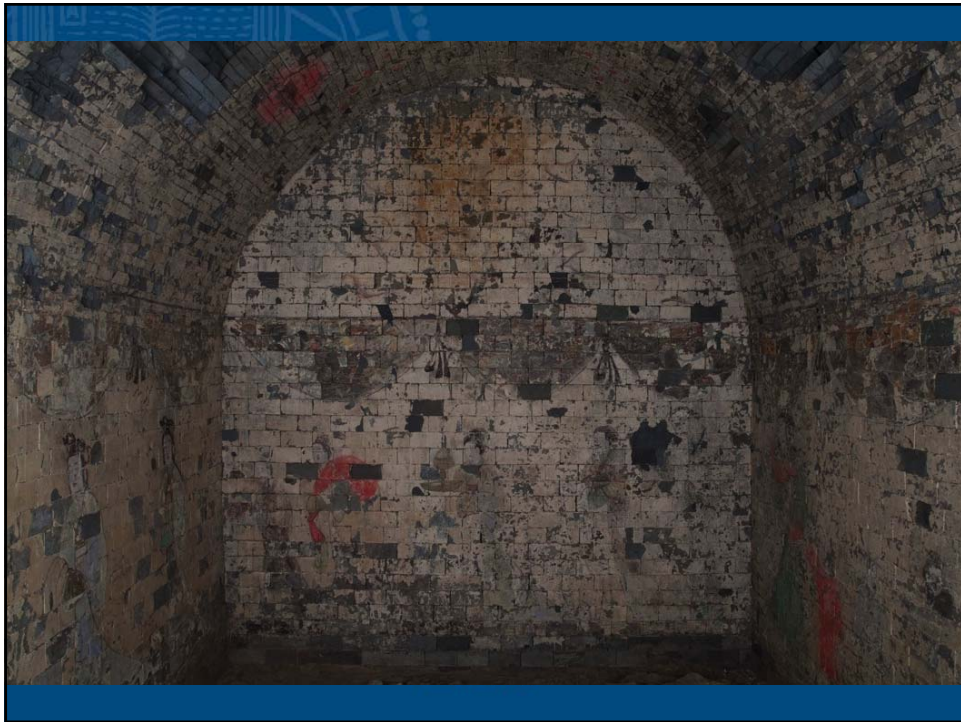


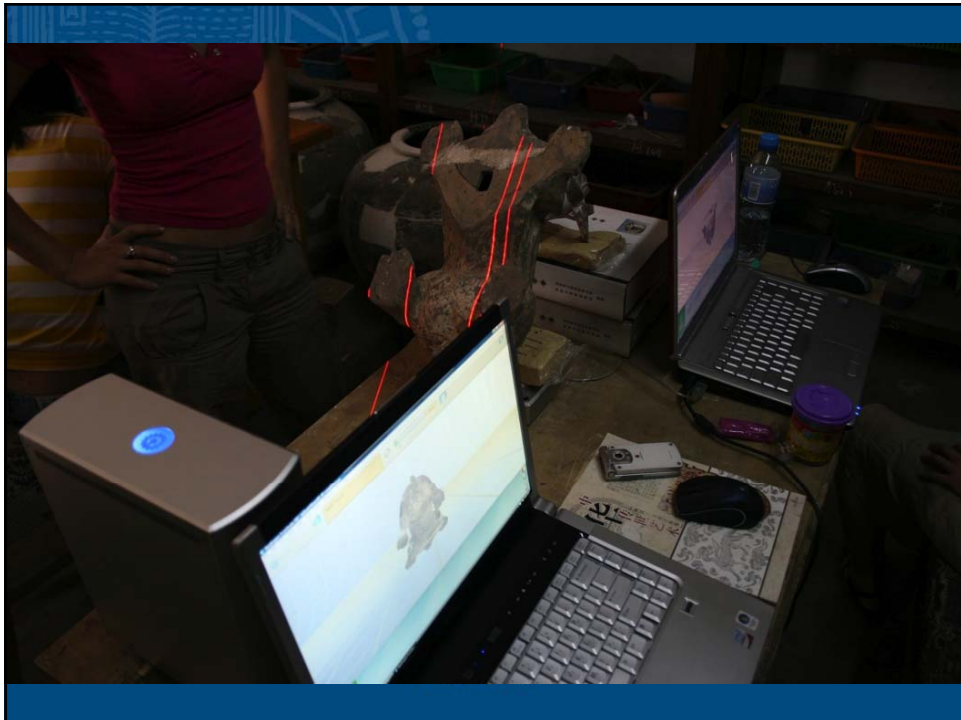


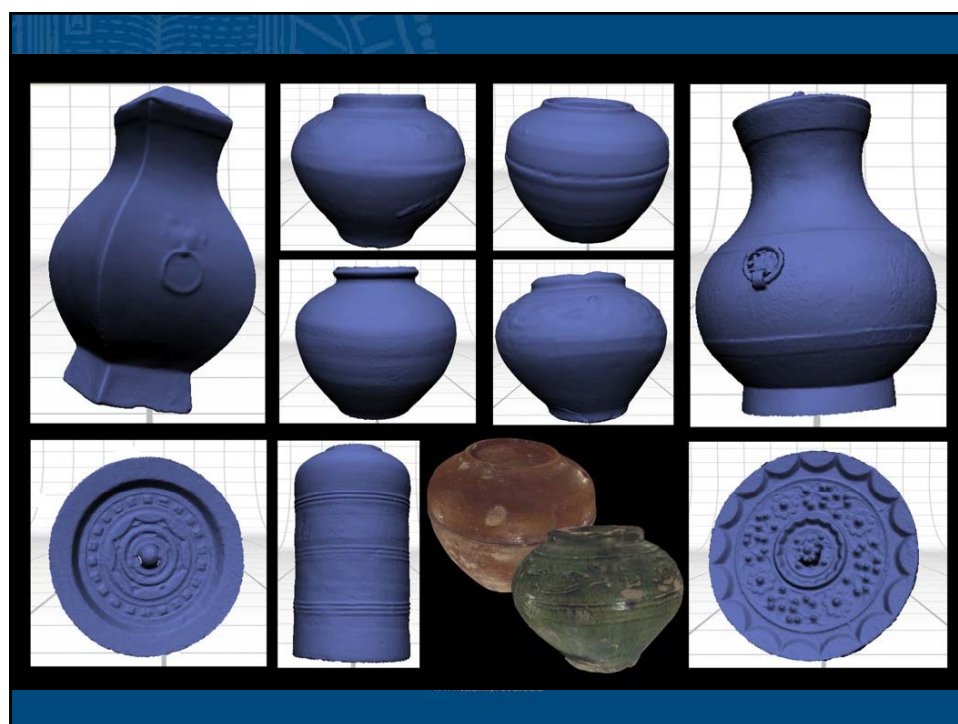


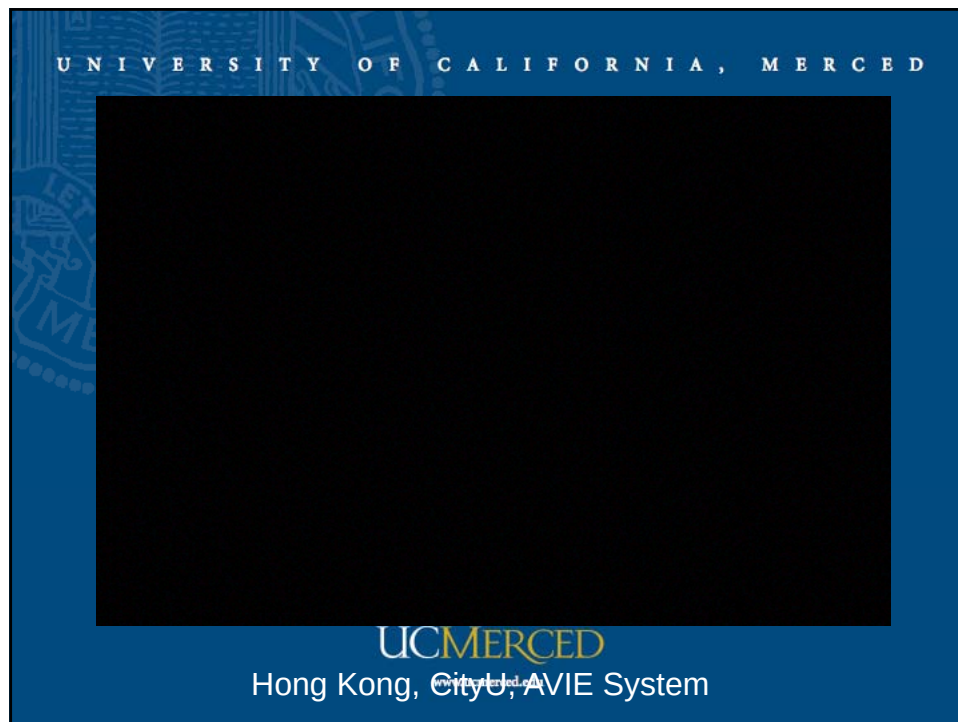












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Teleimmersive Archaeology

Cyberarchaeology

Experimenting with Teleimmersive Archaeology

University of California, Berkeley
University of California, Merced

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CONCLUSIONS

- Simulation and not visualization is the core
- Knowledge is by interaction (the information comes from the feedback)
- Knowledge distributed and augmented by collaborative environments (playing with the data)
- Teleimmersive Technologies create hybrid cyberspaces of simulation, interaction and reconstruction: networks of “minds at work” (new knowledge)

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THANK YOU!

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